

PLASMA DISPLAY MARKET STRUCTURE STUDY

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PLASMA DISPLAY MARKET STRUCTURE STUDY

Prepared For:

INTERNATIONAL BUSINESS MACHINES
SYSTEM COMMUNICATIONS DIVISION

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INPUT



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PLASMA DISPLAY MARKET STRUCTURE STUDY

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PLASMA DISPLAY MARKET STRUCTURE STUDY

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I INTRODUCTION

I INTRODUCTION

A. STUDY OBJECTIVES

- This report was prepared by INPUT as a custom study for the IBM System Communications Division in Kingston, New York.
- The objectives of the market structure study were to:
 - Determine which industries have any interest in flat panel displays.
 - Determine if the industries that have an interest in flat panel displays would pay a premium for some of its features.
 - Determine if any characteristics are a deterrent in some markets.
 - Provide guidance for more specific market research.
 - Provide information concerning the attitudes of vendors and their customers toward new products or technology.

B. METHODOLOGY

- A questionnaire addressing the objectives was prepared by INPUT and modified by the System Communications Division of IBM, Kingston, New York. The questionnaire is contained in Appendix A.
- Telephone interviews were the sole data gathering method used in the study.

- The types of industries interviewed, and the number within each industry, were jointly chosen by IBM and INPUT.
- Each of the interviews was conducted, if possible, with a company representing a different aspect of the designated industry type.
- Attempts were made to interview people who were familiar with their industry as well as with their company's products.
 - The most successful interviews were conducted with product marketing or product planning personnel.
- IBM was never identified.
- INPUT was identified as a market research firm doing an exploratory marketing study.
 - Interviews were performed by INPUT senior staff.
- Section III is a summary of the responses to the questionnaire for those questions where useful information was obtained from most of the respondents.
- Section IV groups all of the additional information given by each respondent in one place, and includes additional information and opinions provided by the respondent.
- An oral presentation was made to IBM in Kingston, New York on February 11, 1980. For the most part, the material presented is Chapter III and Chapter IV of this volume.

II EXECUTIVE SUMMARY

II EXECUTIVE SUMMARY

A. KEY CONCLUSIONS

- Plasma displays have two general types of use. They are:
 - Replacement of CRTs.
 - Brand new applications.
- The replacement of CRTs with plasma displays is attractive due to the following plasma characteristics:
 - Flatness.
 - Ruggedness.
 - Brightness.
 - Size.
 - Flicker free.

- Undesirable characteristics of plasma displays are:
 - Lack of color.
 - Present cost.
- In general, plasma displays must be competitive in cost with CRT displays before they can be looked upon as a CRT replacement.
- Plasma displays have an application in new and growing areas.
 - The games market is a good example.
 - However, vendors in these industries must be shown (by a leader) how to use a plasma display in their products.
- The majority of respondents thought that cost was the key issue in acceptance of plasma displays.
 - Few were willing to pay a large cost premium for plasma displays.
- Respondents are interested in learning more about plasma displays and would like to participate in the next phase of the study.
 - This interest is significant because respondents have not spent a great deal of time thinking through the advantages and uses of plasma displays.
- Respondents think that the market for plasma displays could be accelerated if vendors would:
 - Distribute prototypes.
 - "Sell the idea" to end users.

- Develop a second source (in some industries).

B. RECOMMENDATIONS

- There are two ways in which IBM could enter the market for plasma displays. These are:
 - IBM markets plasma displays as a simple add-on to its own needs.
 - . The add-on viewpoint.
 - IBM provides leadership in applications of plasma display technology. Potential users are educated in the applications and benefits of plasma technology.
 - . The leader viewpoint.
- The definitions of these viewpoints, and their respective advantages and disadvantages, are shown side by side in Exhibits II-1 through II-4.
- The INPUT project manager was asked, "What would you do if you were IBM?" The answer is given in Exhibit II-5, which suggests that IBM become a leader because plasma displays can become a key technology if the price is right.
- Exhibit II-6 contains recommendations for future research.

EXHIBIT II-1

DEFINITIONS OF VIEWPOINTS

ADD-ON VIEWPOINTS

- In following the add-on viewpoint, IBM will:
 - Only sell the same components which it uses internally.
 - Sell in large quantities via specification sheet information.
 - Allow potential users to approach IBM.

LEADER VIEWPOINT

- In following the leader viewpoint, IBM will:
 - Create a market for the technology by:
 - Building demonstration units, to show "it can be done."
 - Attending user and potential vendor trade shows.
 - Providing potential customers with research and assistance.
 - Actively encourage sales by:
 - Calling upon potential users.
 - Providing technical data and assistance.
 - Adopting liberal pricing policies.

EXHIBIT II-2

TARGET MARKETS

IN FOLLOWING THE ADD-ON VIEWPOINT

- IBM will expect to be approached by:
 - Other computer manufacturers.
 - Text editing unit manufacturers.
 - System houses.

IN FOLLOWING THE LEADER VIEWPOINT

- IBM will create markets with:
 - Instrumentation manufacturers.
 - Game manufacturers.
- Personal/small computers will follow.
- Applications will be started with:
 - Other computer manufacturers.
 - Text editing manufacturers.
 - System houses.
- Segments of other markets (such as military) will follow.

EXHIBIT II-3

ADVANTAGES TO IBM

THE ADD-ON VIEWPOINT

- Increased sales volume.
 - Move down the learning curve for lower prices.
- A technology in which IBM has an extremely strong position is a standard of the industry.
- Smaller investment and risk.
 - Minimal marketing.

THE LEADER VIEWPOINT

- Bring the technology further down the learning curve to the point where it is suitable for:
 - Home computers.
 - "On the desk" workstations.
- Put IBM into an even stronger position regarding the technology standard of the industry.
- Allow IBM to move into the consumer market with a reliable technology.
 - Ideal technology for the market.
- Put IBM into the "components" business.

EXHIBIT II-4

DISADVANTAGES TO IBM

THE ADD-ON VIEWPOINT

- Competitors have the same technology as IBM.
 - Minimizing the differential advantages of IBM systems.

LEADER VIEWPOINT

- Higher investment and higher risk.
 - A new product area.
- More management time must be spent.
- Competitors still can build displays/products with the same technology as IBM.

EXHIBIT II-5

A RECOMMENDATION FOR IBM

- Become a leader.
 - It fits the corporate growth pattern.
 - It eases entry with a quality product into the:
 - Consumer market.
 - Desk top terminal market.

EXHIBIT II-6

THE NEXT STEP

- "Design" systems (paper design) to show the advantages of plasma for:
 - Games.
 - Instruments.
- Discuss these ideas, in person, with prospective users via:
 - Single meeting.
 - Focus group sessions.
(Selling the idea discussions).
- The best focus group sessions would show a "working display."
- Determine what price would "make it fly."
 - Assumptions necessary to achieve this price:
 - Quantity sold.
 - Tooling.
 - Technical "breakthrough."

III QUESTIONNAIRE ANALYSIS

III QUESTIONNAIRE ANALYSIS

- In this section, the responses are summarized by industry type.
 - Section IV contains more detailed information by specific respondent.
- The companies listed in Exhibit III-1 are grouped into the categories jointly chosen by IBM and INPUT.
- In many cases, division information was not available with respect to sales and employees, so corporate information was included.
- The respondents ranged from vice presidents, through marketing and engineering managers, to engineers and product specialists.
- Since several companies were interviewed in each industry type, the range of answers within an industry category represents the variations within that industry.
- The sales cycle in consumer products and personal/small business systems is virtually non-existent because all sales are to large distributors (Exhibit III-2).
- In government systems, the product development cycle is very long for a number of reasons. A major one is the necessity of getting mil-spec approval on new components after they have been integrated into the system.

EXHIBIT III-I

CHARACTERISTICS OF COMPANIES INTERVIEWED

- COMPUTER MANUFACTURERS

A	Sales:	\$120 million
	Employees:	1,700
	Interviewee:	Dir. Corp. Prod. Development
B	Sales:	\$4 billion (Corp.)
	Employees:	90,000 (Corp.)
	Interviewee:	Mgr. Terminal Prod. Planning

- TERMINAL MANUFACTURERS

A	Sales:	\$4 billion (Corp.)
	Employees:	90,000 (Corp.)
	Interviewee:	Mgr. Prod. Marketing
B	Sales:	\$10 million
	Employees:	180
	Interviewee:	Prod. Specialist

EXHIBIT III-I

(continued)

- INSTRUMENT MANUFACTURERS

A	Sales:	\$15 million
	Employees:	300
	Interviewee:	Mgr. Prod. Safety Engineering
B	Sales:	\$50 million (Corp.)
	Employees:	1,200 (Corp.)
	Interviewee:	Mgr. Prod. Marketing
C	Sales:	\$150 million
	Employees:	4,600
	Interviewee:	Principal Engineer

- CONTROL SYSTEMS MANUFACTURERS

A	Sales:	\$4 billion (Corp.)
	Employees:	90,000 (Corp.)
	Interviewee:	Supervisor, Automation Design
B	Sales:	\$1 billion (Corp.)
	Employees:	25,000 (Corp.)
	Interviewee:	Mgr. Analog Control Div.
C	Sales:	\$75 million
	Employees:	2,000
	Interviewee:	Application Engineer

EXHIBIT III-I

(continued)

• COMMUNICATIONS EQUIPMENT MANUFACTURERS	A	Sales:	\$15 million
		Employees:	400
		Interviewee:	Dir. Prod. Planning
	B	Sales:	\$120 million
		Employees:	700
		Interviewee:	Project Eng.
	C	Sales:	\$28 million
		Employees:	600
		Interviewee:	Mgr. Prod. Marketing
	D	Sales:	\$1.5 billion (Corp.)
		Employees:	25,000 (Corp.)
		Interviewee:	Mgr. Applications Marketing

EXHIBIT III-I

(continued)

- WORD PROCESSING MANUFACTURERS

A	Sales:	\$200 million
	Employees:	4,000
	Interviewee:	Prod. Manager
B	Sales:	\$100 million
	Employees:	Unknown
	Interviewee:	Prod. Manager
C	Sales:	\$1.5 billion (Corp.)
	Employees:	55,000 (Corp.)
	Interviewee:	Dir. Planning (subsidiary)

- GOVERNMENT SYSTEMS VENDORS

A	Sales:	\$15 million
	Employees:	350
	Interviewee:	Mgr. Prod. Marketing
B	Sales:	\$3.5 billion (Corp.)
	Employees:	62,000 (Corp.)
	Interviewee:	Mgrs. Human Factors, Training Systems
C	Sales:	\$4 billion (Corp.)
	Employees:	90,000 (Corp.)
	Interviewee:	Mgr. Design Engineering

EXHIBIT III-I

(continued)

- CONSUMER PRODUCTS
MANUFACTURERS

A	Sales:	\$20 million
	Employees:	400 (peak)
	Interviewee:	V.P. Marketing
B	Sales:	Would not disclose
	Employees:	Would not disclose
	Interviewee:	Mgr. Design Engineering
C	Sales:	Would not disclose
	Employees:	Would not disclose
	Interviewee:	Product marketing

EXHIBIT III-I

(continued)

- PERSONAL/SMALL BUSINESS COMPUTER MANUFACTURERS

A	Sales:	\$100 million (Corp.)
	Employees:	Would not disclose
	Interviewee:	V.P. Systems Technology
B	Sales:	Would not disclose
	Employees:	Would not disclose
	Interviewee:	Mgr., Prod. Marketing
C	Sales:	\$190 million
	Employees:	4,500
	Interviewee:	Mgr., Display Planning
D	Sales:	Would not disclose
	Employees:	Would not disclose
	Interviewee:	V.P. Technology

EXHIBIT III-I

(continued)

- SYSTEM HOUSES

A	Sales:	\$18 million
	Employees:	Would not disclose
	Interviewee:	Senior V.P.
B	Sales:	\$120 million
	Employees:	7,000
	Interviewee:	Dir. Planning
C	Sales:	\$200 million
	Employees:	4,000
	Interviewee:	Mgr. Market Operations

EXHIBIT III-2

AVERAGE SALES AND PRODUCT DEVELOPMENT CYCLES

INDUSTRY	AVERAGE CYCLE	
	SALES	PRODUCT DEVELOPMENT
Computer Manufacturers	3-12 months	2 years
Terminal Manufacturers	6-12 months	1-2 years
Word Processing Systems	2-6 months	0.5-2 years
Government Systems	Bid to spec. - 24 months	up to 5 years
Instrumentation	1-6 months	8-24 months
Control Systems	4-8 months	0.5-3 years
Communications Equipment	3-12 months	0.5-2 years
Consumer Products	Distributors	3-12 months
Personal/Small Business Systems	Distributors	0.5-2 years
System Houses	1 month	1-6 months

- Displays are an important part of the products of most of the companies interviewed.
 - A wide variation exists in government systems, control systems, and communications equipment (Exhibit III-3).
- Most respondents did not know how many displays were shipped in their industries last year.
- Most respondents also refused to disclose how many displays their company shipped last year.
 - When prodded, most interviewees felt their industries would grow substantially during the next five years barring a major recession (Exhibit III-4).
- The factors that the respondents deemed important when choosing a new display were very industry specific:
 - Reliability under 24 hour usage was important in two industries (Exhibit III-5).
 - Higher cost, while a major factor in most industries, didn't rule out new displays entirely if the other features would enable the product or system to command a premium price or open new markets.
- In asking respondents about desirable characteristics (Exhibit III-6) and undesirable characteristics (Exhibit III-7), the desirable ones were industry specific.
 - Generally, there was no characteristic that people found undesirable. The only strange characteristic was the orange color, so it was chosen (picked on).

EXHIBIT III-3

INDUSTRY IMPORTANCE OF DISPLAYS TO PRODUCTS

INDUSTRY	IMPORTANCE
Computer Manufacturers	Increasingly important
Terminal Manufacturers	Crucial
Word Processing	Essential
Government Systems	Varies from nonexistent to essential
Instrumentation	Essential
Control Systems	Moderately important to essential
Communications Equipment	Variable
Consumer Products	Heart of product
Personal/Small Business Systems	Crucial
System Houses	Critical

EXHIBIT III-4

EXPECTED SHIPMENT GROWTH OVER THE NEXT FIVE YEARS

INDUSTRY	GROWTH
Computer Manufacturers	Triple, 20% of total products
Terminal Manufacturers	30%/year
Word Processing	10-15% per year, 10 times
Government Systems	Dramatic increase
Instrumentation	10% per year
Control Systems	Dramatic, same rate as electric power industry
Communications Equipment	25-30% per year, tremendous
Consumer Products	At least double, parallels technology.
Personal/Small Business Systems	2-4 times per year
System Houses	800% (individual company growth)

EXHIBIT III-5

FACTORS ENTERING INTO DECISIONS TO USE A NEW DISPLAY DEVICE

INDUSTRY	FACTORS
Computer Manufacturers	Cost effectiveness, open new markets
Terminal Manufacturers	Cost, resolution ruggedness
Word Processing	Clarity, size, image retentivity
Government Systems	Customer acceptance, reliability, mil-spec.
Instrumentation	Reliability - 24 hour usage
Control Systems	Lowest cost meeting spec.
Communications Equipment	Power, cost, 24 hour usage
Consumer Products	Cost of electronics, availability
Personal/Small Business Systems	Availability, marketing advantage
System Houses	Compatibility, price, service

EXHIBIT III-6

CHARACTERISTICS MENTIONED THAT MIGHT MAKE THE DISPLAY DESIRABLE

INDUSTRY	DESIRABLE CHARACTERISTICS
Computer Manufacturers	Size, implied legibility
Terminal Manufacturers	Flatness, graphics, ruggedness
Word Processing	Brightness, size, depth
Government Systems	Brightness, black background, depth
Instrumentation	Low voltage, flicker free
Control Systems	Brightness, flicker free
Communications Equipment	None
Consumer Products	Ruggedness, pixels
Personal/Small Business Systems	Portability, depth, graphics
System Houses	Depth, no refresh

EXHIBIT III-7

CHARACTERISTICS MENTIONED THAT MIGHT MAKE THE DISPLAY UNDESIRABLE

INDUSTRY	UNDESIRABLE CHARACTERISTICS
Computer Manufacturers	Reflectivity, static
Terminal Manufacturers	Color
Word Processing	Color, too large
Government Systems	Color, big hardware box
Instrumentation	Color
Control Systems	Lack of color, temp. range
Communications Equipment	Color, power, programming
Consumer Products	Color, programming
Personal/Small Business Systems	Lack of color
System Houses	Price

- In some industries, a red or orange color indicates an alarm condition and cannot be used.
- The degree of compatibility, especially of programming compatibility, was of concern to many respondents.
 - Programming costs are a major portion of the overall system or product cost, and if reprogramming was necessary for a new display, the display might not be chosen unless the additional expense could be justified on some outstanding features at increased sales advantage.
- The ease with which a new display could be introduced depended upon many factors. In Exhibit III-8, the use of the term "interface" when associated with "easy" means: if the electronic and programming interfaces are the same or very similar, then the introduction would be easy.
 - The abbreviation "cons." means: the customers are very conservative, so a new display would be hard to introduce.
- In general, plasma displays as described were thought of as CRT replacements (Exhibit III-9).
 - It was very difficult to get respondents to "freely associate," to think of new ways to use the display based upon a brief telephone introduction. A dynamic demonstration with new uses emphasized would stimulate creative thinking.
- In few industries would the described display solve specific problems that were only marginally solved with CRTs (Exhibit III-10).
 - In aircraft displays, special filters must be manufactured at considerable expense in order to avoid "washout" in cockpit brightness. The bright orange on black might alleviate the problem and reduce manufacturing costs.

EXHIBIT III-8

EASE WITH WHICH A NEW DISPLAY COULD BE INTRODUCED

INDUSTRY	RELATIVE EASE OF ENTRY
Computer Manufacturers	Hard (cost), Easy (interface)
Terminal Manufacturers	Easy (novel), Hard (cost)
Word Processing	Easy (cost, interface)
Government Systems	Hard (mil-spec)
Instrumentation	Easy (edge), Hard (cons.)
Control Systems	Hard (cons.)
Communications Equipment	Easy (new func.), Hard (cost)
Consumer Products	Easy (novel), Hard (cost)
Personal/Small Business Systems	Easy
System Houses	Easy

EXHIBIT III-9

POSSIBLE DISPLAY USE

INDUSTRY	HOW USED
Computer Manufacturers	CRT replacement, specials
Terminal Manufacturers	Mixed systems
Word Processing	Mgmt. Terminals, W.P.
Government Systems	Graphics, CRT replacement
Instrumentation	CRT replacement
Control Systems use	CRT replacement, wouldn't
Communications Equipment use	CRT replacement, wouldn't
Consumer Products	CRT replacement
Personal/Small Business Systems display	160 char/line business
System Houses	CRT replacement

EXHIBIT III-10

PROBLEMS DISPLAY USE WOULD SOLVE

INDUSTRY	PROBLEMS SOLVED
Computer Manufacturers	Space, small graphics
Terminal Manufacturers	None
Word Processing	Klutziness, 2 pages
Government Systems	Eliminate filtering
Instrumentation	High voltage, implosion risk
Control Systems	Small graphics, remote
Communications Equipment	None
Consumer Products	Fragility
Personal/Small Business Systems	Portability
System Houses	None

- In patient monitoring equipment, the high voltage and implosion risks of CRTs are always concerns. Both would be eliminated with reliable plasma technology.
- In order to use the new display in the various industries, all respondents wanted their engineering departments to test samples.
- Beyond that, there were some specific needs addressable prior to display use (Exhibit III-11):
 - . Get mil-spec. approval for government systems.
 - . Get UL and FDA approval for medical instrumentation and patient monitoring.
 - . Since most game manufacturers use two different microprocessors, a standard microprocessor interface should be chosen.

EXHIBIT III-11

WORK NEEDED PRIOR TO DISPLAY USE

INDUSTRY	PREPARATORY WORK
Computer Manufacturers	Cost justify
Terminal Manufacturers	Test samples
Word Processing	Test and experiment
Government Systems	Mil-spec. approval
Instrumentation	UL & FDA approval
Control Systems	Customer acceptance
Communications Equipment	Prove usefulness
Consumer Products	Use standard interface
Personal/Small Business Systems	Reprogram
System Houses	Std. keyboard interface

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IV INDUSTRY PROFILES

IV INDUSTRY PROFILES

A. INTRODUCTION

- In this chapter, each of the respondent interviews are summarized.
 - The responses follow the pattern of the questionnaire, but each has been individualized depending upon the biases of the respondent.
- Respondent A felt that the space taken up by CRTs has already been worked into system cost justifications and saving space isn't saving costs.
 - He also felt that flat panel displays, while the "wave of the future," won't proliferate because they will be more expensive than CRTs. When flat panels can be grown like chips then their "age" will dawn.
- Respondent C uses flat displays at airline centers and would like to eliminate the bulk of the keyboard at the counters.
- The coin-operated video game manufacturers (Section I) showed the most interest in the display.
 - The industry thrives on novelty.
 - CRTs are very fragile in a video game environment.

- Space-saving features would be useful in new multiple display games that are in the planning stages.

B. COMPUTER MANUFACTURERS

I. RESPONDENT A

- Designs and manufactures small and medium computer systems.
- Display percentage of product cost:
 - Small.
 - Depends upon number of displays/system.
- Display shipments will triple over next five years.
- Cost effectiveness most important factor.
- Space has already been cost justified.
- Competition:
 - Ball Brothers new 10" diagonal 35 MHz tube with 132 characters, 5 dots wide, at \$225-275 for monitor.
 - Standard monitor available for \$40.
 - Zenith has 18 MHz monitor kit for \$70.
- Can be sold on "Pizzazz."

- Flat panels are the future.

2. RESPONDENT B

- Designs and manufactures complete computer line.
- Displays:
 - 10% of total product shipped.
 - About 500,000 displays shipped in industry last year.
 - Displays will be 20% of total product shipped in 5 years.
- Displays are approximately 20% of product cost.
- Important factors for choosing new display:
 - Customer acceptance - no software changes.
 - Open new markets.
 - Price trade-off with maintenance.
- Desirable characteristics:
 - Use same product worldwide.
 - No interface or software changes.
- Undesirable characteristics and concerns:
 - Reflectivity of ambient light.

- Possible harmful side effects on people.
 - Static charges.
- Uses:
 - Where size is important.
 - Factory environment, if it won't melt.
- Advice:
 - Approach big companies through product planning groups.
 - Let companies buy in development quantities.
 - Later, consider licensing.

C. TERMINAL MANUFACTURERS

I. RESPONDENT C

- Assembles interactive systems, manufactures terminals.
- Sells primarily to banking, airlines, and manufacturing industries.
- Systems are frequently mixed.
 - Plasma and CRTs are used in banking and factory data collection.

- Displays used:
 - Factory data collection - Plasma display 1"X5" for one line of large A/N characters.
 - Banking - 5" diagonal CRT or Plasma display for 1 or 2 lines of A/N data.
 - Airlines - use abbreviations to cut transmission costs and increase interactive speed.
- Displays are 5-10% of product cost at monitor level for plasma or CRTs.
- Important factors for choosing new display:
 - Cost.
 - Applications applicability.
 - Ruggedness, sometimes.
 - Must have second source.
- Desirable characteristics:
 - Ruggedness.
 - Graphics, if at no extra cost.
- Undesirable characteristics:
 - Color, 10% of population is red/orange color blind.

- Easy to introduce.
 - Novel, small.
 - Cost-conscious customers may not pay for novelty.
 - Used mostly on mixed systems.
 - Keyboard at airlines counter is bulky.
- Advice:
 - Try touch panel for airlines.
 - Get samples to engineering departments.

2. RESPONDENT D

- Designs and manufactures graphic display systems.
- Markets are military and in manufacturing design.
- Shipments should grow 30%/yr. over next 5 years.
 - Eighty percent (80%) of current shipments are monochrome.
- Typical system has 1-4 21" vector refresh monochromic displays.
 - Analog and digital interface.
 - Input from all usual devices.
 - Tube is less than 5% of product cost.

- Important factors for choosing new display:
 - Cost.
 - Resolution, line width should be 10-15 mils.
 - Good end point matching.
 - Short- and long-term repeatability.
 - Minimal spot motion.
- Desirable characteristics:
 - Lack of curvature is sometimes important.
- Undesirable characteristics:
 - People are used to B/W - orange may be a problem.
- Hard to introduce new display.
 - Industry is satisfied.
 - Cost may be greater.
- Used for special projects.
 - Occurs less than 5% of the time.
- Advice:
 - Sell it to users, then vendors will switch.

D. WORD PROCESSING MANUFACTURERS

I. RESPONDENT E

- Designs and manufactures systems for graphic arts industry.
 - Ad agencies, newspapers, printing companies and publishers.
 - Editing, phototypesetting, and word processing systems.
- Industry display shipments last year in 5,000-10,000 range.
 - Growth is expected to be 10-15%/yr.
- Three (3) types of displays used:
 - Thirteen or fourteen inch (13" or 14") CRT for standard editing and word processing.
 - Sixteen thousand (16,000) character CRT for ad layouts.
 - Fine spot tube (1 mil spot) for phototypesetting.
- Typical system:
 - Ad layout - one display per system.
 - Phototypesetting - one fine spot display and one standard display.
 - Data entry for reporters - 10-15 standard displays per system. Recent installation - 200 displays.

- Sixteen thousand (16,000) character display monitor costs about \$400 in quantities.
- Important factors for choosing new display:
 - Overall size.
 - Cost - especially cost of electronics.
 - Image retentivity must be low.
 - Second source is very important.
- Desirable characteristics:
 - Lack of curvature.
 - Depth.
 - All points addressable.
 - No refresh.
- Undesirable characteristics:
 - Orange - green is supposed to be soothing.
- How could it be used:
 - In all applications if it met specs.
 - Programming is 85-90% of new system cost.

- Advice:
 - Get samples to field.
- 2. RESPONDENT F
- Designs and manufactures standard word processing systems.
 - Sold to large company typing pools, lawyers, insurance offices.
- Shipments will grow 10 times in next 5 years.
- Uses three types of displays:
 - Three by eight inch (3"X 8") CRT for 8 lines.
 - Little larger than 8½"X 11" for full page.
 - Nineteen inch (19") diagonal for two full pages - vector stroke.
- Typical system:
 - Full page display.
 - Nineteen inch (19") display use is rapidly increasing.
- Display is about 20% of product cost.
 - Buys tube - adds drivers and analog interface.
- Important factors for choosing new display:
 - Cost - pays premium now for vector stroke.
 - Clarity, eye fatigue.

- Ease of displaying special characters and fonts.
- Reduced service and maintenance.
- Desirable characteristics:
 - No refresh.
- Undesirable characteristics:
 - Test black and orange.
 - Could be too bright.
- Easy to introduce.
 - Operator interface remained same.
 - Perhaps less eye strain.
- Industry problems solved:
 - Display two pages - vector stroke clumsy, raster scan terrible.
- To be done before using:
 - Safety/hazard testing.
 - Extensive operator testing.
- Advice:
 - OEM device only.

- Optional packaging.
- Prepare to license.

3. RESPONDENT G

- Designs and assembles range of word processing and office systems.
- Sell primarily to Fortune 1000 companies and branches.
- Display cost:
 - Terminal is about 5-10% of product cost.
 - Monitor is about 20% of dumb terminal cost.
 - Current monitor is \$50-75.
- Important factors for choosing a new display:
 - Price - shouldn't be more than \$100-\$150 for monitor.
 - Depth is great.
 - Density should be at least 100 dots/in., or 10 char/in.
 - Service and maintainability factors.
- Desirable characteristics:
 - Brightness.
 - Lack of depth.

- Undesirable characteristics:
 - Large - 9"X 10" would be better.
- Ease of introduction:
 - Easy - need same interface.
 - Price no more than double today's CRT monitor.
- Problems solved:
 - "Klutziness" for management terminals.
- Advice:
 - Get samples around now if it will be available in quantity in two years.

E. GOVERNMENT SYSTEMS VENDORS

I. RESPONDENT H

- Designs and manufactures display systems for military aircraft, and ground stations.
- Bid to spec:
 - Development cycle is 2 years after bid is won.
 - Nothing is "off the shelf."
- Dramatic increase in shipments expected over next 5 years.

- Typical system:
 - Five to seventeen inch (5"-17") diagonal CRT.
 - More than one size in a system.
 - Color desired but too expensive.
- Displays represent 15-20% of product cost.
- Important factors for choosing new displays:
 - Customer's spec.
 - Supplier reputation.
 - Wide temperature range.
 - Vibration sensitivity.
 - Reliability.
 - Second source.
- Undesirable characteristics:
 - Orange color - red/orange is military warning or danger color.
- Hard to introduce new display.
 - Military inertia.
- Used for all displays if price is right.

- Industry problems it might solve:
 - CRT filtering not required.
 - Lower manufacturing cost.
- Advice:
 - Patience - average 7 years to get first major order.
 - Get prototype to military evaluation labs.
 - Let military use it so it can get into specs.

2. RESPONDENT I

- Designs and manufactures military space systems such as:
 - Space craft.
 - Ground handling and support systems.
 - Telemetry DP systems.
 - Satellite tracking systems.
 - Training systems.
- Product development cycle can be up to 5 years.
 - Sales cycle can last 2 years.
- All products have some displays.

- Unmanned space craft have none.
- Significant growth is expected.
- Typical systems:
 - Large size CRTs used for A/N information.
 - Some tracking and graphics CRTs are also used.
 - Gas panel displays used but are too bulky.
- Important factors for choosing new display:
 - Reliability.
 - Maintainability.
 - Brightness.
 - Supplier reputation.
 - Mil-spec.
- Desirable characteristics.
 - Depth.
 - Brightness.
 - Flicker free.
 - Ruggedness.

- Undesirable characteristics:
 - All points addressable.
 - Complex programming.
- Easy to introduce.
 - Space industry at forefront of new technology.
 - Currently using the only plasma display available.
- Industry problems solved:
 - CRTs not bright enough.
 - Fragility.
 - Operator "sick" time.
- Advice:
 - Have control programs available.
 - Package it in demonstration systems that emphasize thinness and other features.

3. RESPONDENT J

- Designs and builds sonar systems for the United States Navy.
- Product cycle is 5-10 years.
 - Sales cycle is 2-3 years.

- Displays shipped last year - 8 (company).
- Displays are 15-30% of multimillion dollar systems cost.
- Typical system:
 - Several cabinets of digital/analog electronics.
 - One to four displays, 10"X 12", for sensor output in gray scale.
 - Graphics output in monochrome.
- Important factors for choosing new displays:
 - Bandwidth and resolution.
 - . Five hundred by five hundred (500X500) points/sq. in. std, 1000X1000 points has been quoted.
 - Gray scale.
 - . Eight (8) levels needed (3 bits).
 - Price.
 - Service and reliability.
 - Mil-spec.
- Desirable characteristics:
 - Depth.
 - Ruggedness.

- Undesirable characteristics:
 - No gray scale.
- Hard to introduce.
 - System must get mil-spec. approval with display - takes 5 years.
- Might be used for graphic displays for the communications equipment.
- Advice:
 - Don't compete with CRTs for sensor output.
 - Look to other defense data output areas.

F. INSTRUMENTATION MANUFACTURERS

I. RESPONDENT K

- Designs and manufactures patient monitoring equipment.
- Growth - 10%/year.
- Uses range of CRTs from 5" up to 19".
 - Portable units use 5".
 - Bedside monitoring uses one medium size.
 - Nurses stations use one large size for several patients simultaneously.

- Tube is 3-4% of product cost.
 - Standard glass - phosphor and gun are custom.
 - Costs \$30-100.
- Important factors for choosing new display:
 - Reliability and life running 24 hours/day.
 - Price.
 - Size for portable equipment.
- Desirable characteristics:
 - Low voltages.
 - No magnetic fields.
 - Flicker free.
- Undesirable characteristics:
 - Orange and black, possibly.
- Easy to introduce.
 - Competitive edge.
- Industry problems solved:
 - High voltage hazard.

- Implosion hazard.
- Fragility in portable equipment.
- Need FDA and UL approval for medical equipment.
- Advice:

- Test it running 24 hours/day.
- Get to companies for 2 months of tests.

2. RESPONDENT L

- Designs and manufactures direction finding instruments, electronic display systems, flight information systems, and scoreboards.
- Majority of displays are simple A/N in large size.
 - Typical size is 4'X 8'.
- Generally uses light bulbs because of cost.
 - Complex display not needed.
- Might be useful for small annunciators.
- Advice:
 - This is not a current market.

3. RESPONDENT M

- Designs and manufactures instrument systems for process control systems.

- Displays are critical as the window to the user.
- Shipped 30 systems, each with 3-4 displays.
- Displays are 80-90% color (7 colors plus black).
 - Overview displays show alarms and statistics.
 - Other displays show greater detail over less area.
 - Graphic displays show system schematics.
- Displays are 20-25% of system costs.
- Important factors for choosing new display:
 - Nineteen inch (19") display with color.
 - Price.
 - Service, reliability, maintainability.
 - Supplier reputation as a good OEM supplier.
- Desirable characteristics:
 - Brightness.
 - Nineteen inch.
 - Resolution.
 - No refresh.

- Addressability.
- Undesirable characteristics:
 - Red means alert - orange is too close.
 - Can it blink?
- Conservative industry - hard to introduce.
- Suggestions:
 - User selectable intensity control on different areas.
 - User control to reduce glare.
 - Replace light pen with touch panel.

G. CONTROL SYSTEMS MANUFACTURERS

- I. RESPONDENT N
- Designs and manufactures building environment control systems.
- Expect dramatic growth.
- Uses 12", 15", and 19" color CRTs.
 - One to two CRTs per system.
 - CRTs average \$2,000 to \$3,000/system.

- Free standing, RS 232 interface.
- Reliability, color, and temperatures to 120° F are important.
- CRTs sometimes not fast enough.
- Might be used for remote small graphics.
- Advice:
 - Let manufacturers sell it to users.

2. RESPONDENT O

- Designs and manufactures control systems for electric power industry.
- Growth will parallel electric power industry growth.
- Typical system:
 - \$4.5-9 million.
 - Seven to fourteen consoles each with 2-3 displays.
 - One 19" or 25" color CRT and 1 or 2 14" color CRTs.
 - Typical color monitor price is about \$2,600.
- Hard to introduce.
 - Will use lowest cost display that meets spec.

- Advice:
 - Sell it to customers and industry consultants.

3. RESPONDENT P

- Designs and manufactures fluid process control systems.
- Expected growth-10%/year.
- Typical system:
 - Two to three (2-3) 19" color displays in console or free standing.
 - Displays are 2-5% of a \$2-4 million system.
- Advice:
 - Go to color - all control industry is color now.

H. COMMUNICATIONS EQUIPMENT MANUFACTURERS

I. RESPONDENT Q

- Designs and manufactures message switching systems and other communications products.
- Industry growth - 25-30%/year.
- Uses the most common, least expensive display.
- Requires excellent reliability running 24 hours/day.
- Would only consider if cost is lower.

- Advice:
 - Show it at trade shows to generate interest.
- 2. RESPONDENT R
- Designs and manufactures CBX and private telephone equipment.
- Display importance:
 - Message centers - very.
 - Telephones - moderately.
 - CBX - moderately.
- Tremendous growth, company has been doubling each year.
- Ninety-nine percent (99%) of displays shipped are LEDs.
- Typical systems:
 - Small business telephones - 8 A/N, 7 segment LEDs plus 11 LED on/off indicators.
 - Message center - new product, uses dumb ADM 3 CRT type.
 - CBX - 7 segment LEDs - may go to dumb CRT.
- All LEDs in telephone cost about \$10, or 3% of product cost.
- Important factors:
 - Brightness in office environment.

- Low power consumption.
 - Second source or guarantee of 50,000 units/year.
- Undesirable features:
 - Too much power for telephone.
 - Too complex.
- Advice:
 - Be willing to make custom production runs for 50,000 units/year.
3. RESPONDENT S
- Designs and manufactures transmission and reception equipment for facsimile services.
 - Expected growth - 50%/year.
 - Displays used:
 - Fourteen (14) digit numeric dialer display (2 per system).
 - Sees no need for any other display now.
 - Advice:
 - Let advance planning groups play with it for future products.

4. RESPONDENT T

- Designs and manufactures test equipment for telecommunications systems and networks.
- Expected growth - 20%/year.
- Uses a 15 A/N character LED display.
 - Costs less than \$50 on a \$10,000 instrument.
- Not interested in anything else now.

I. CONSUMER PRODUCT MANUFACTURERS

I. RESPONDENT U

- Designs and manufactures coin-operated video and pinball games.
- Games shipped last year - 100,000-150,000.
 - Growth parallels technology, novelty and invention.
- Typical system:
 - One 19" or 23" display per video game.
 - Multiple displays soon.
 - Display is major cost in game retailing for \$2,000.
 - Pinball machines use LEDs, current plasma is unreliable.

- Desirable features:
 - Ruggedness.
 - Depth and flatness.
 - Pixels.
 - Concerns:
 - Realism versus color combination.
 - Full color sometimes desirable.
 - Amount and complexity of electronics required.
 - Interface two microprocessors.
 - Gas discharge reliability.
 - Easy introduction.
 - Advice:
 - Stay with large display.
 - Consider licensing.
 - Give engineers samples.
2. RESPONDENT V
- Designs and manufactures pinball machines.

- Shipments expected to double in five years.
- About 250,000 games shipped last year, each with 2-3 displays.
- Claims everyone uses gas discharge displays in pinball games except himself.
He uses electroluminescent panels.
- Display represents 10% of cost without electronics.
- Uses only numerics - no need for anything more complex.
- Future games would probably use it.
- Advice:
 - Send out product literature.
 - Get prototypes tested by manufacturers.
 - Publish reliability data.
 - Provide a second source of supply.
 - Keep cost down.

3. RESPONDENT W

- Designs and manufactures coin-operated video games.
- Growth at least 20%/year.
 - Could go up if new, novel technology comes along.
 - About 150,000 games shipped last year.

- Uses one display/game currently.
 - Quadrascan XY monitor with bright white lines giving almost 3D appearance.
 - Display is major hardware cost item in game.
 - Expensive to produce shading.
- Desirable features:
 - Versatility of image.
 - Small graphic possibility.
- Concerns:
 - 3D effect possibilities are good.
 - Orange color needs testing.
 - Complex programming is usually necessary for all points addressable displays.
 - Display should be microprocessor driven.
- Advice:
 - Let game programmers at it to see what can be done.

J. PERSONAL/SMALL BUSINESS COMPUTER MANUFACTURERS

I. RESPONDENT X

- Designs and manufactures personal and small business systems.
- Expected growth - triple each year.
 - Three hundred thousand (300,000) units shipped last year.
- All displays are 80 characters by 25 lines, basically.
 - One display per very small business or personal system.
 - Monitor is less than 10% of the cost of a \$700-1,000 retail product price.
- Desirable features:
 - Gives market advantage.
 - Depth and small graphics in portable unit.
 - Business will pay for 160 characters/line.
- Fears excessive programming and memory for graphics.
- Advice:
 - Show it to potential buyers with cost data.

2. RESPONDENT Y

- Designs and manufactures personal and small business systems.
- Five hundred thousand (500,000) personal computers shipped in total.
 - If price is right, a display could be shipped with 75% of future shipments.
- Types of systems:
 - Business system - display is 10% of cost, B/W fine.
 - Home system - display is 25% of cost, full color.
 - Personal system - display is 25% of cost, either type.
- Important factors to consider:
 - Needs quantities in excess of 1,000/month.
 - Reasonably rugged.
 - Color or shades of gray.
 - Easily interfaced - TTL is okay.
 - Reprogramming.
- Orange might be a problem.
 - Prefer full color or B/W, B/G.
- Solves part of portability problem.

- Space.
 - Needs too much power for battery operation.
- Advice:
 - Have chief engineer sign non-disclosure agreement and let him test.
3. RESPONDENT Z
- Designs and manufactures small business systems.
 - Expected growth - more than double in five years.
 - Two major monitor suppliers shipped about 300,000 each.
 - Total is between 600,000 and 750,000 last year.
 - Typical system:
 - Uses standard 2,000 character CRTs.
 - Average system is four displays, but is increasing.
 - On very large system, displays may be 50% of product cost.
 - Finds no reason to consider this display.
 - Prefers tried and proven CRTs.
 - Customer demand could change his mind.
 - Won't look at new markets - can't produce enough to meet current demand.

- Advice:
 - Let Honeywell, IBM, and Hewlett-Packard do human factors testing.
- 4. RESPONDENT AA
- Designs and manufactures small computers for home and office.
- Expected growth - 50%/year.
- Typical system:
 - One standard 80 character by 25 line display/system.
- Display cost data:
 - Five to ten percent (5-10%) of product cost for monitor.
 - One hundred twenty dollars (\$120) on an \$1,800 system at cost (B/W monitor).
- Personal computers are all going to color.
 - Graphics also, but after color.
- Easy to introduce - hobbyist wants latest.
- Advice:
 - Plasma will never be low enough in price until they use it for television sets.
 - Try making a color plasma display.

K. SYSTEM HOUSES

I. RESPONDENT BB

- Integrate hardware and software for general purpose business system.
- Company display shipments growth:
 - 1979 - 2,000 displays.
 - 1980 - 4,000 displays.
 - 1985 - 15,000-16,000 displays.
- Company spends \$80,000-90,000/year for tubes.
- Typical system:
 - Five to eight (5-8) standard 80 characters by 25 line displays.
 - CRTs are 25% of system cost.
- Important factors for choosing new display:
 - Compatibility with software.
 - Price.
 - Physical characteristics.
 - . Eighty (80) characters by 25 lines at least.
 - . Seven by nine (7X9) dot matrix minimum.

- . Accept ASCII and foreign character sets.
 - . RS232 interface.
 - Easy to introduce.
 - Keyboard or keyboard interface necessary.
 - Advice:
 - If premium priced, go for special industries, not general purpose marketplace.
 - Try engineering, design graphics, or the education market.
2. RESPONDENT CC
- Integrates peripherals and adds operating system software.
 - Product cycle - 5 years.
 - Sales cycle - 3 months.
 - Company spends \$5-10 million/year for displays.
 - One thousand (1,000) diagnostic systems.
 - Eight to nine thousand (8,000-9,000) terminal based systems.
 - Typical system:
 - Diagnostic system - one 19" standard B/W CRT.
 - Terminal systems - multiple 19" standard B/W CRTs.

- Less than 10% of product cost is due to displays.
 - All displays are 'bare bones'.
 - Price is prime criteria.
 - No features are worth more money.
 - Advice:
 - Find network of system houses with unique requirements.
3. RESPONDENT DD
- Integrates and manufactures peripherals and DDP systems.
 - Expected growth - 30%/year.
 - Typical system:
 - Three standard B/W displays.
 - Displays are \$6,000 of a \$25,000 system, at retail.
 - Important factors for choosing a new display:
 - Price.
 - Service accessibility.
 - Physical characteristics.

- Desirable characteristics:
 - Orange/black.
 - Depth.
 - No refresh.
- Hard to introduce.
 - Would have to be superior.
 - Price competitive.
- Advice:
 - Tack on prices and let's talk again.

APPENDIX A: PRIOR WORK

EXHIBIT A-1

PRIOR WORK WITH IBM (Custom Studies)

- Providing CRT terminals to "third party vendors", March, 1978.
- Teletype Compatible CRT Terminal Market, March, 1979.
- IBM 3270 Plug Compatible Terminal Pricing Study, August, 1979.
- Synchronous Terminal Pricing Practices, November, 1979.
- Small Business Systems Marketing Survey, January, 1980.
- These studies included:
 - Characteristics of terminal marketplace.
 - Analysis of terminal manufacturers.
 - Desires of system houses.

**APPENDIX B: COMPANIES TYPICAL OF
THOSE INTERVIEWED**

**APPENDIX B: COMPANIES TYPICAL OF THOSE INTERVIEWED
(ACTUAL COMPANIES MAY OR MAY NOT BE INCLUDED)**

Computer Manufacturers

- Pertec Computer Corporation
- General Automation, Inc.
- Sperry Rand Corporation
- Honeywell, Inc.

Terminal Manufacturers

- Adage, Inc.
- Terminal Data Corporation
- Sperry Rand Corporation
- Raytheon, Inc.

Word Processing Manufacturers

- Harris Corporation, Composition Division
- Eltra Corporation, Mergenthaler Division
- Exxon Enterprises, Vydec Division
- Exxon Enterprises, Quip Division
- Burroughs Corporation, Redactron Division

Government Systems Vendors

- Sperry Rand Corporation
- Honeywell, Inc.
- Lockheed, Inc.
- Bendix Corporation
- A-T-O, Inc.
- Boeing Corporation

Instrument Manufacturers

- Electro-Nucleonics
- Datascope Corporation
- Federal Signal Corporation
- American Sign & Indicator Corporation
- International Rectifier Corporation
- General Time Corporation

Control Systems Manufacturers

- General Signal Corporation (Division)
- W. R. Grace Co. (Division)
- Honeywell, Inc. (Division)
- Crane Co. (Division)
- Mudland Ross Corporation (Division)
- LFE Corporation (Division)

Communications Equipment Manufacturers

- Lynch Communications Systems, Inc.
- Dynatech Corporation
- Dataproducts of New England
- RFL Industries
- Scientific-Atlanta, Inc.

- Farinon Corporation
- Lear Siegler, Inc. (Division)
- Harris Corporation (Division)

Consumer Products Manufacturers

- Bally Manufacturing Corporation (Division)
- Atari Corporation (Division)
- Gottlieb Manufacturing Corporation
- Cinematronics, Inc.
- Ramtek, Inc.
- Taitronics Corporation

Personal/Small Business Computer Manufacturers

- Commodore International Ltd.
- Apple, Inc.
- Cromemco, Inc.
- Southwest Technical Laboratories
- Ohio Scientific, Inc.
- Exidy (Division)
- Wang Laboratories, Inc.
- North Star Computers, Inc.

System Houses

- Cado Systems Corporation
- Qantel Corporation
- Minicomputer Systems, Inc.
- Storage Technology Corporation (Division)
- Mohawk Data Systems, Inc.
- Educational Data Systems

APPENDIX C: QUESTIONNAIRE

DISPLAY MARKET STRUCTURE STUDY

A. INTRODUCTION

INPUT is investigating applications of a new type of display and would like about a half an hour of your time to describe it to you and to share ideas concerning it. In return for your time INPUT will send you a summary of the study.

First, I would like to briefly describe the display features, then I would like some information about your industry, and the industries that buy your products, after which we can discuss any application ideas you might have.

- Display characteristics.
 - Bright, rugged, flat.
 - Available in sizes less than 5"x7" up to a display face with a 19" diagonal.
 - Depth can be as little as 1 to 3 inches depending upon screen size.
 - No refresh necessary.
- Graphics capability.
 - All points are addressable.
 - Can be made to display all fonts, languages, signatures, engineering drawings and newspaper photos.
 - The 19" screen can display 4 standard CRT screens of 2,000 characters each or 2 full 8½"x11" pages of text.

- System/subsystem availability.
 - Full system with standard voltages, digital interface and power supply.
 - Display with driver electronics requiring a separate 100 volt DC power supply.
 - Display component only.

B. QUESTIONNAIRE

Ia. Please describe your industry.

Ib. How many companies are there in your industry and in the industries that use your products?

Your industry _____

Industries that use your products _____

Ic. What are the products of your company/division?

Id. Please describe the value added by your company?

Ie. What is your company's approximate sales volume?

If. What is the average:

- Sales cycle.
- Product cycle.

Ig. What is your job function?

- 2a. How important are displays to products in your industry? By application, please.
- 2b. How much is spent on displays by your company and in your industry? By application, please.
- 2c. How many displays were shipped by your company and in your industry last year?
- 2d. How do you expect shipments to grow over the next five (5) years?

- 2e. If different kinds of displays were shipped, could you break the shipments down by type, please?
- 2f. Could you describe a typical system and the types of displays used in each application?
- 2g. To what type of users do you ship these systems?
- 2h. What percentage of product cost is due to displays? By application, please.

3. What factors enter into decisions to use a new display device?

* Interviewer - After getting some answer suggest the following:

- Price.
- Capability (describe how).
- Physical characteristics.
- Service and accessibility.
- Reliability.
- Supplier reputation.
- Supplier relationship (describe).

4a. What characteristics mentioned might make it desirable to you?

4b. What characteristics would make it undesirable to you?

4c. How easy would it be to introduce a new display into your industry?

4d. How might it be used in your industry?

4e. What problems would it solve in your industry?

4f. How would you quantify the savings?

• Consider such items as:

- Operator productivity.
- Maintenance cost.
- Manufacturing cost.

4g. What would have to be done before you could use it in applications for your industry?

4h. What do you think of the following ideas?

(Interviewer suggests applications pertinent to specific industry.)

5a. What suggestions do you have concerning the display? Describe?

* Interviewer - Wait for a reply and then ask:

5b. How important might the following attributes be and why?

- Display characteristics.
- Price.
- Reliability.

6. What advice do you have for vendors of such displays?

